U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY DOCKET NUMBER
GRP-0011

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
10/049415

INTERNATIONAL APPLICATION NO. **PCT/DK00/00442**	INTERNATIONAL FILING DATE **9 August 2000**	PRIORITY DATE CLAIMED **9 August 1999**

TITLE OF INVENTION
SIGNAL PROCESSING UNIT

APPLICANT(S) FOR DO/EO/US
KIM RISHOJ PEDERSEN, ET AL.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.

4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).

5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))

    a. ☒ is attached hereto (required only if not communicated by the International Bureau).

    b. ☐ has been communicated by the International Bureau.

    c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).

    a. ☐ is attached hereto.

    b. ☐ has been previously submitted under 35 U S C. 154(d)(4).

7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))

    a. ☐ are attached hereto (required only if not communicated by the International Bureau).

    b. ☐ have been communicated by the International Bureau.

    c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.

    d. ☐ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 U.S C. 371 (c)(4)).

10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).

12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:
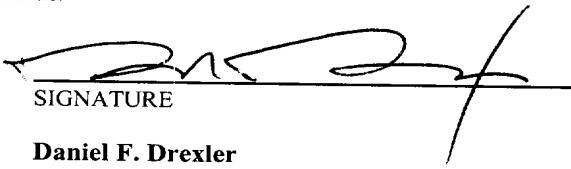
13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

15. ☒ A **FIRST** preliminary amendment.

16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.

17. ☐ A substitute specification.

18. ☐ A change of power of attorney and/or address letter.

19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.

20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).

21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).

22. ☒ Certificate of Mailing by Express Mail

23. ☐ Other items or information:

JC11 ... 0 8 FEB 2002

24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1040.00

☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00

☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00

☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00

☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00

CALCULATIONS PTO USE ONLY

ENTER APPROPRIATE BASIC FEE AMOUNT = $890.00

Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)). $0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	14 - 20 =	0	x $18.00	$0.00	
Independent claims	7 - 3 =	4	x $84.00	$336.00	
Multiple Dependent Claims **(check if applicable).**		☐		$0.00	

TOTAL OF ABOVE CALCULATIONS = $1,226.00

☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2. $0.00

SUBTOTAL = $1,226.00

Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). + $0.00

TOTAL NATIONAL FEE = $1,226.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐ $0.00

TOTAL FEES ENCLOSED = $1,226.00

Amount to be: refunded	$
charged	$

a. ☒ A check in the amount of _____$1,226.00_____ to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. _____06-1130_____ A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Daniel F. Drexler
CANTOR COLBURN LLP
55 Griffin Road South
Bloomfield, CT 06002
Telephone: 860-286-2929
Customer No. 23413

SIGNATURE

Daniel F. Drexler
NAME

47,535
REGISTRATION NUMBER

08 FEBRUARY 2002
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#4/
/a

IN RE APPLICATION OF: KIM RISHOJ PEDERSEN, ET AL.

FOR: MULTI CHANNEL PROCESSING METHOD

PRELIMINARY AMENDMENT

The Assistant Commissioner of
Patents and Trademarks
Washington, DC 20231

Dear Sir:

     Prior to the Examiner acting in the above-referenced application, please
preliminary amend the claims as follows:

IN THE SPECIFICATION:

     Please insert the following paragraph before the paragraph beginning on page 1,
line 4:

--**Cross Reference to Related Applications**

This application is related to the commonly assigned application entitled "Multi Channel
Processing Method" (Attorney Docket No. GRP-0010), filed concurrently herewith,
which is incorporated herein by reference in its entirety.--

     Please replace the paragraph on page 1, lines 5-9, with the following rewritten
clean version:

--The invention relates to a system for processing audio signals, and more particularly, to
a system for providing a room simulation for processing audio signals in multiple
channels.--

     Please replace the paragraph on page 2, line 22, with the following rewritten clean
version:

--The signal processing unit comprising--

Please replace the paragraph on page 3, lines 26-27, with the following rewritten clean version:

--The unit further comprises a direction rendering unit (201) having an input for signals having N directional components,--

Please replace the paragraph on page 4, lines 11-14, with the following rewritten clean version:

--The P channel output signals are established in such a way that they correspond to a P-channel trans- or bin-aural representation of the N-directional input signal, an advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 4, lines 16-19, with the following rewritten clean version:

--The P channel output signals are established in such a way that they correspond to an experience-based P-channel representation of the N-directional input signal, a further advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 4, lines 25-32, with the following rewritten clean version:

--The signal processing unit further comprises a circuit (202, 203) having S inputs and P outputs, the said S inputs being individual input channels for S input sources, the P channel outputs comprising a P-channel late reverberation signal, the signal processing unit further comprising a summing unit (204), the summing unit (204) adding the late reverberation signal to the established P-channel output signals of the direction rendering unit (201), a further advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 5, lines 15-19, with the following rewritten clean version:

--The rendering unit comprises an input for N directional signals, the direction rendering unit (201) establishing a P channel output signal on an output of the rendering unit (201)

corresponding to input signals having N directional components, a further advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 6, lines 4-7, with the following rewritten clean version:

--The P channel output signals are established in such a way that they correspond to a P-channel trans-aural representation of the N-directional input signal, a further advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 6, lines 9-12, with the following rewritten clean version:

--The P channel output signals are established in such a way that they correspond to an experience-based P-channel representation of the N-directional input signal, a further advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 6, lines 14-21, with the following rewritten clean version:

--The early pattern generation mixer (29) comprises M inputs, each input receiving early pattern signals comprising N directional components, the mixer (29) further comprising at least one output, the at least one output transmitting an N-directional early patterns signal, the N-directional early patterns signal being established by adding the M inputs, a further advantageous embodiment of the invention has been obtained as a mix of the very complex directional signal may be established by simple summing.--

Please replace the paragraph on page 6, lines 23-31, with the following rewritten clean version:

--The signal processing unit comprises at least one input (S), at least one of the inputs (S) being connected to at least one space processor, at least one space processor defining at least a generation of an early pattern each of said space processors establishing an output (d1, d2, d3, d4,..,dN) having N directional components, each of the directional components (N) of the outputs being added to form at least one signal having N

directional components, a further advantageous embodiment of the invention has been obtained.--

Please replace the paragraph on page 7, lines 1-5, with the following rewritten clean version:

--The method of representing an audio-signal, wherein said signal is decomposed to a signal comprising N directional components, an advantageous signal representation has been obtained as a directional representation facilitates the possibility of a true and relatively simple processing of even very complicated audio signal scenarios.--

Please replace the paragraph on page 8, lines 1-5, with the following rewritten clean version:

--The signal is decomposed to a signal comprises N directional components by means of dedicated signal-processing means, an advantageous embodiment of the invention has been obtained as the signals may be established in real-time.--

Please replace the paragraph on page 8, lines 7-15, with the following rewritten clean version:

--The method of processing audio signals comprises M sub-signals, each sub-signal being represented as a signal having N directional components (d1, d2, d3, d4,..), the sub-signals being added to form a sum-signal having N directional components (Σd1, Σd2, Σd3, Σd4,..,ΣdN), where Σdi(i=1..N) is the sum of signal components in one of the N directions, the sum-signal representing the resulting audio signal, a further advantageous embodiment of the invention has been obtained as even very complicated audio-signals may be added by means of conventional summing means to form a complex and true signal which may establish several sound source positions in one signal.--

Please replace the paragraph on page 8, lines 17-27, with the following rewritten clean version:

--The signal processing unit comprises at least one input (S), at least one of the inputs (S) being connected to at least one reverberation unit at least one reverberation unit defining

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a predefined reverberation generation each of the reverberation units establishing an output (d1, d2, d3, d4,...) having N directional components, each of said directional components (N) of said outputs being added to form at least one signal having N directional components, a further advantageous embodiment of the invention has been obtained as the signal-representation and signal-processing algorithm may basically be processed on both initial sound signals and the sound tail signal as well according to the invention.--

Please replace the section heading on page 8, line 29, with the following rewritten section heading:

--**Detailed Description of the Drawings**--.

Please replace the section heading on page 9, line 7, with the following rewritten section heading:

--**Detailed Description of Preferred Embodiments**--.

IN THE CLAIMS:

Please replace claims 1-14 with the following rewritten clean versions:

1. (Amended) A signal processing unit comprising:

at least one input; and

at least one early pattern generator for defining a predefined early pattern generation, said at least one early pattern generator being connected to said at least one input, each of said at least one early pattern generator establishing an output having N directional components, each of said N directional components of said outputs being added to form at least one signal having N directional components.

2. (Amended) The signal processing unit according to claim 1, further comprising a direction rendering unit with an input for signals having N directional components, said direction rendering unit establishing P channel output signals on an output of the direction rendering unit corresponding to input signals having N directional components.

3. (Amended) The signal processing unit according to claim 2, wherein said P channel output signals are established in such a way that said P channel output signals correspond to a P-channel trans- or bin-aural representation of said input signals having N directional components.

4. (Amended) The signal processing unit according to claim 2, wherein said P channel output signals are established in such a way that said P channel output signals correspond to an experience-based P-channel representation of said input signals having N directional components.

5. (Amended) The signal processing unit according to claim 1, further comprising:

a circuit having S inputs and P outputs, said S inputs being individual input channels for S input sources, said P outputs comprising a P-channel late reverberation signal; and

a summing unit for adding said late reverberation signal to said established P-channel output signals of said direction rendering unit.

6. (Amended) A direction rendering unit comprising an input for N directional signals, said direction rendering unit establishing a P channel output signal on an output of the direction rendering unit corresponding to input signals having N directional components.

7. (Amended) The direction rendering unit according to claim 6, wherein said P channel output signals are established in such a way that said P channel output signals correspond to a P-channel trans-aural representation of said input signals having N directional components.

8. (Amended) The direction rendering unit according to claim 6, wherein said P channel output signals are established in such a way that said P channel output signals

correspond to an experience-based P-channel representation of said input signals having N directional components.

9. (Amended) An early pattern generation mixer comprising:

M inputs each of which receives early pattern signals comprising N directional components; and

at least one output for transmitting an N-directional early pattern signal, said N-directional early pattern signal being established by adding said M inputs.

10. (Amended) A signal processing unit comprising:

at least one input; and

at least one space processor for defining at least a generation of an early pattern, said at least one space processor being connected to said at least one input, each of said at least one space processor establishing an output having N directional components, each of said N directional components of said outputs being added to form at least one signal having N directional components.

11. (Amended) A method of representing an audio-signal, wherein said signal is decomposed to a signal comprising N directional components.

12. (Amended) The method according to claim 11, wherein said audio signal is decomposed to a signal comprising N directional components by means of dedicated signal-processing means.

13. (Amended) A method of processing audio signals comprising M sub-signals, each of said M sub-signals being represented as a signal having N directional components, said M sub-signals being added to form a sum-signal having N directional components, wherein each of said N directional components of said sum-signal is equal to a sum of signal components in one of N directions, said sum-signal representing a resulting audio signal.

14. (Amended) A signal processing unit comprising:

at least one input; and

at least one reverberation unit for defining a predefined reverberation generation, said at least one reverberation unit being connected to said at least one input, each of said at least one reverberation unit establishing an output having N directional components, each of said N directional components of said outputs being added to form at least one signal having N directional components.

IN THE ABSTRACT:

Please replace the abstract with the following rewritten clean version:

Abstract of the Disclosure

The invention relates to a signal processing unit including an input for receiving an audio signal, and an early pattern generator connected to the input, for defining a predefined early pattern generation. The early pattern generator establishes an output having N directional components which are added to form a signal having N directional components. When representing each source output in a direction containing representation both directionality of the individual sound sources as well as the resulting directionality of the excited sound propagation may be contained and processed in a simple processing algorithm.

REMARKS

Applicants request entry of the above-identified amendments which conform the claims to U.S. practice. No new matter is being introduced by this Amendment as antecedent support is set forth in the specification and the original claims.

Prosecution on the merits is respectfully requested.

If there are any charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130 maintained by Applicants' attorneys.

Respectfully submitted,
KIM RISHOJ PEDERSEN, ET AL.

CANTOR COLBURN LLP
Applicants' Attorney

By: _____
Daniel F. Drexler
Registration No. 47,535
Customer No. 23413

Date: 08 February 2002
Telephone: 860-286-2929

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

SPECIFICAITON AMENDMENTS

   Please amend the paragraph on page 1, lines 5-9 as follows:

The invention relates to a [signal processing unit according to claim1, a

rendering unit according to claim 6, an early pattern mixer according to claim 9, a

method of representing an audio-signal according to claim 11, a method of processing

audio signals according to claim 13 and a signal processing unit according to claim 14]

system for processing audio signals, and more particularly, to a system for providing a

room simulation for processing audio signals in multiple channels.

   Please amend the paragraph on page 2, line 22, as follows:

[When, as stated in claim 1, the] The signal processing unit comprising

   Please amend the paragraph on page 3, lines 26-27, as follows:

[When, as stated in claim 2, the said] The unit further comprises a direction rendering

unit (201) having an input for signals having N directional components,

   Please amend the paragraph on page 4, lines 11-14, as follows:

[When, as stated in claim 3, the said] The P channel output signals are established in such

a way that they correspond to a P-channel trans- or bin-aural representation of the [said]

N-directional input signal, an advantageous embodiment of the invention has been

obtained.

   Please amend the paragraph on page 4, lines 16-19, as follows:

[When, as stated in claim 4, the said] The P channel output signals are established in such

a way that they correspond to an experience-based P-channel representation of the [said]

N-directional input signal, a further advantageous embodiment of the invention has been

obtained.

   Please amend the paragraph on page 4, lines 25-32, as follows:

[When, as stated in claim 5, the said] The signal processing unit further comprises a circuit (202, 203) having S inputs and P outputs, the said S inputs being individual input channels for S input sources,

the [said] P channel outputs comprising a P-channel late reverberation signal,

the [said] signal processing unit further comprising a summing unit (204),

the [said] summing unit (204) adding the [said] late reverberation signal to the [the said] established P-channel output signals of the [said] direction rendering unit (201), a further advantageous embodiment of the invention has been obtained.

Please amend the paragraph on page 5, lines 15-19, as follows:

[When, as stated in claim 6, the] The rendering unit comprises an input for N directional signals,

the [said] direction rendering unit (201) establishing a P channel output signal on an output of the rendering unit (201) corresponding to input signals having N directional components, a further advantageous embodiment of the invention has been obtained.

Please amend the paragraph on page 6, lines 4-7, as follows:

[When, as stated in claim 7, the said] The P channel output signals are established in such a way that they correspond to a P-channel trans-aural representation of the [said] N-directional input signal, a further advantageous embodiment of the invention has been obtained.

Please amend the paragraph on page 6, lines 9-12, as follows:

[When, as stated in claim 8, the said] The P channel output signals are established in such a way that they correspond to an experience-based P-channel representation of the [said] N-directional input signal, a further advantageous embodiment of the invention has been obtained.

Please amend the paragraph on page 6, lines 14-21, as follows:

[When, as stated in claim 9, the] The early pattern generation mixer (29) comprises

M inputs, each input receiving early pattern signals comprising N directional components,

the [said] mixer (29) further comprising at least one output, the [said] at least one output transmitting an N-directional early patterns signal,

the [said] N-directional early patterns signal being established by adding the [said] M inputs, a further advantageous embodiment of the invention has been obtained as a mix of the very complex directional signal may be established by simple summing.

Please amend the paragraph on page 6, lines 23-31, as follows:

[When, as stated in claim 10, the] <u>The</u> signal processing unit comprises

at least one input (S),

at least one of the [said] inputs (S) being connected to at least one space processor,

at least one space processor defining at least a generation of an early pattern

each of said space processors establishing an output (d1, d2, d3, d4,..,dN) having N directional components,

each of the [said] directional components (N) of the [said] outputs being added to form at least one signal having N directional components, a further advantageous embodiment of the invention has been obtained.

Please amend the paragraph on page 7, lines 1-5, as follows:

[When, as stated in claim 11, the] <u>The</u> method of representing an audio-signal, wherein said signal is decomposed to a signal comprising N directional components, an advantageous signal representation has been obtained as a directional representation facilitates the possibility of a true and relatively simple processing of even very complicated audio signal scenarios.

Please amend the paragraph on page 8, lines 1-5, as follows:

[When, as stated in claim 12, the said] <u>The</u> signal is decomposed to a signal comprises N directional components by means of dedicated signal-processing means, an advantageous embodiment of the invention has been obtained as the signals may be established in real-time.

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Please amend the paragraph on page 8, lines 7-15, as follows:

[When, as stated in claim 13, the] <u>The</u> method of processing audio signals comprises M sub-signals, each sub-signal being represented as a signal having N directional components (d1, d2, d3, d4,..), the [said] sub-signals being added to form a sum-signal having N directional components (Σd1, Σd2, Σd3, Σd4,..,ΣdN), where Σdi(i=1..N) is the sum of signal components in one of the N directions, the [said] sum-signal representing the resulting audio signal, a further advantageous embodiment of the invention has been obtained as even very complicated audio-signals may be added by means of conventional summing means to form a complex and true signal which may establish several sound source positions in one signal.

Please amend the paragraph on page 8, lines 17-27, as follows:

[When, as stated in claim 14, the] <u>The</u> signal processing unit comprises

at least one input (S),

at least one of the [said] inputs (S) being connected to at least one reverberation unit

at least one reverberation unit defining a predefined reverberation generation

each of the [said] reverberation units establishing an output (d1, d2, d3, d4,...) having N directional components,

each of said directional components (N) of said outputs being added to form at least one signal having N directional components, a further advantageous embodiment of the invention has been obtained as the signal-representation and signal-processing algorithm may basically be processed on both initial sound signals and the sound tail signal as well according to the invention.

Please amend the section heading on page 8, line 29, as follows:

[The figure] <u>**Detailed Description of the Drawings**</u>

Please amend the section heading on page 9, line 7, as follows:

Detailed [description] <u>Description of Preferred Embodiments</u>

CLAIM AMENDMENTS

Please amend claims 1-14 as follows:

1. (Amended) [Signal] A signal processing unit comprising:

at least one input [(S),]; and

[at least one of the said inputs (S) being connected to] at least one early [patterns] pattern generator [(M),

at least one early pattern generator (M)] for defining a predefined early pattern generation, said at least one early pattern generator being connected to said at least one input,

each of [the] said at least one early pattern generator [(M)] establishing an output [(d1, d2, d3, d4,...)] having N directional components,

each of said N directional components [(N)] of said outputs [(d1, d2, d3, d4,...)] being added to form at least one signal having N directional components.

2. (Amended) [Signal] The signal processing unit according to claim 1, [wherein the said unit also comprises] further comprising a direction rendering unit [(201)] with an input for signals having N directional components,

[the] said direction rendering unit [(201)] establishing [a] P channel output signals on an output of the direction rendering unit [(201)] corresponding to input signals having N directional components.

3. (Amended) [Signal] The signal processing unit according to claim 2, wherein said P channel output signals are established in such a way that [they] said P channel output signals correspond to a P-channel trans- or [bin aural] bin-aural representation of [the] said [N-directional] input [signal] signals having N directional components.

4. (Amended) [Signal] The signal processing unit according to claim 2, wherein [the] said P channel output signals are [establishes] established in such a way that [it corresponds] said P channel output signals correspond to an experience-based P-channel representation of [the] said [N-directional] input [signal] signals having N directional components.

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5. (Amended) [Signal] The signal processing unit according to [claims] claim 1 [to 4], [wherein the said signal processing unit also comprises] further comprising:

a circuit [(202, 203)] having S inputs and P outputs, [the] said S inputs being individual input channels for S input sources,

[the] said P [channel] outputs comprising a P-channel late reverberation signal[,]; and

[the said signal processing unit further comprising] a summing unit [(204)]

[the said summing unit (204)] for adding [the] said late reverberation signal to [the] said established P-channel output signals of [the] said direction rendering unit [(201)].

6. (Amended) [Rendering] A direction rendering unit comprising an input for N directional signals,

[the] said direction rendering unit [(201)] establishing a P channel output signal on an output of the direction rendering unit [(201)] corresponding to input signals having N directional components.

7. (Amended) [Rendering] The direction rendering unit according to claim 6, wherein [the] said P channel output signals are established in such a way that [they] said P channel output signals correspond to a P-channel trans-aural representation of [the] said [N-directional] input [signal] signals having N directional components.

8. (Amended) [Rendering] The direction rendering unit according to claim 6, wherein [the] said P channel output signals are established in such a way that [it corresponds] said P channel output signals correspond to an experience-based P-channel representation of [the] said [N-directional] input [signal] signals having N directional components.

9. (Amended) [Early] An early pattern generation mixer [(29)] comprising:

M inputs[, each input receiving] each of which receives early pattern signals comprising N directional components[,]; and

[the said mixer (29) further comprising] at least one output[, the said at least one output] for transmitting an N-directional early [patterns] pattern signal,

[<

The] said N-directional early pattern signal being established by adding [the] said M inputs.

10. (Amended) [Signal] A signal processing unit comprising:

at least one input [(S),]; and

[at least one of the said inputs (S) being connected to] at least one space processor[,

at least one space processor] for defining at least a generation of an early pattern, said at least one space processor being connected to said at least one input,

each of [the] said at least one space [processors] processor establishing an output [(d1, d2, d3, d4,..dN)] having N directional components,

each of [the] said N directional components [(N)] of [the] said outputs [(d1, d2, d3, d4,...)] being added to form at least one signal having N directional components.

11. (Amended) [Method] A method of representing an audio-signal, wherein [the] said signal is decomposed to a signal comprising N directional components.

12. (Amended) [Method] The method according to claim 11, wherein [the] said audio signal is decomposed to a signal comprising N directional components by means of dedicated signal-processing means.

13. (Amended) [Method] A method of processing audio signals comprising M sub-signals, each [sub-signal] of said M sub-signals being represented as a signal having N directional components [(d1, d2, d3, d4,..,dN)], [the] said M sub-signals being added to form a sum-signal having N directional components, [(Σd1, Σd2, Σd3, Σd4,..,ΣdN) where Σdi(i=1..N)] wherein each of said N directional components of said sum-signal is [the]

equal to a sum of signal components in one of [the] N directions, [the] said sum-signal representing [the] a resulting audio signal.

14. (Amended) [Signal] A signal processing unit comprising:

at least one input [(S),]; and

[at least one of the said inputs (S) being connected to] at least one reverberation unit

[at least one reverberation unit] for defining a predefined reverberation generation, said at least one reverberation unit being connected to said at least one input,

each of [the] said at least one reverberation [units] unit establishing an output [(d1, d2, d3, d4,..,dN)] having N directional components,

each of [the] said N directional components [(N)] of [the] said outputs [(d1, d2, d3, d4,...)] being added to form at least one signal having N directional components.

ABSTRACT AMENDMENTS

Please amend the Abstract as follows:

[Abstract:] **Abstract of the Disclosure**

The invention relates to a signal processing unit [comprising

at least one input (S),

at least one of the said inputs (S) being connected to at least one early pattern

generator (M),

at least one early pattern generator (M) defining a predefined early pattern generation

each of the said early pattern generators (M) establishing an output (d1, d2, d3,

d4,...,dN) having N directional components,

each of the said directional components (N) of the said outputs (d1, d2, d3, d4,...) being

added to form at least one signal having N directional components.] including an input

for receiving an audio signal, and an early pattern generator connected to the input, for

defining a predefined early pattern generation. The early pattern generator establishes an

output having N directional components which are added to form a signal having N

directional components. When representing each source output in a direction containing

representation both directionality of the individual sound sources as well as the resulting

directionality of the excited sound propagation may be contained and processed in a

simple processing algorithm.

SIGNAL PROCESSING UNIT

Field of the invention

5   The invention relates to a signal processing unit according to claim 1, a

rendering unit according to claim 6, an early pattern mixer according to claim 9, a

method of representing an audio-signal according to claim 11, a method of

processing audio signals according to claim 13 and a signal processing unit

according to claim 14.

10

Background of the invention

A reverberation imparting device is generally understood as a sound processing unit

processing input signals representing an acoustic sound in such a way that the

processed input signals are modified into an artificially established signal having

15   desired acoustic properties as if the input signals were present in a certain room such

as concert halls or the like.

Due to the relatively substantial requirements to the necessary hardware, the above-

described technical discipline has been developed only recently.

20

The greatly improved facilities and possibilities of the commercially available digital

signal processing processors and the correspondingly improved supporting A/D and

D/A converting hardware have nevertheless provided a significant push-forward, as

relatively large data streams may be processed, thus still improving the possibility of

25   emulating the physical reality to a higher degree.

Nevertheless, it is still a fact that a true emulation of even a simple room may be

quite complicated, both when considering the establishing of the theoretically

necessary basics and the necessary supporting hardware.

30

A problem with the conventional technique, especially at the recording stage, is that naturalness is harder to obtain when the emulated sound image consists of several sound sources located in a simulated room.

5 Typically, sound rendering of multiple sound sources are generated by room simulators having one or two inputs and the processed input sound from the different sound sources basically shares the same early reflection pattern.

Consequently, the different sound sources are piled on top of each other in the
10 resulting created sound image. The quality of this sound piling is far from convincing and simple individual panning of each source will still suffer from equal sound impression due to the shared early reflection pattern.

An additional problem will arise with multi-channel recordings as each source should
15 be handled very carefully in order to achieve naturalness.

It is one object of the invention to provide a room simulation for multi-channel sound processing.

20 **Summary of the invention**

When, as stated in claim 1, the signal processing unit comprising

at least one input (S),
25 at least one of the said inputs (S) being connected to at least one early patterns generator (M),
at least one early pattern generator (M) defining a predefined early pattern generation each of the said early pattern generator (M) establishing an output (d1, d2, d3, d4,..,dN) having N directional components,
30 each of said directional components (N) of said outputs being added to form at least one signal having N directional components,

an advantageous signal processing unit has been obtained as the result of each source may be added in a relatively simple operation to form a true representation of a real sound field being established in a real room.

5   When representing each source output in a direction containing representation both directionality of the individual sound sources and the resulting directionality of the excited sound propagation may be contained and processed in a simple processing algorithm.

10   Moreover, the directional representation may be established according to psycho-acoustic knowledge about human hearing. Thus, a directional representation having most directional components concentrated at directions of which the human ear may acknowledge real differences.

15   According to the invention, as directional summing has proven to accumulate both the true 0th order directional sound signal (i.e. the direct sound signal) as well as the more complex directional reverberation signal.

A further aspect of an embodiment of the invention is that the initial sound signal
20   processing may be established more or less separately from the establishing of the tail-sound signal. Accordingly, the direct sound and the low order reflections may be established by carefully tuning all implied early pattern generators, mixing the different sound signal into one initial sound signal representing all source signals, and adding the sound tail to the signal after the rendering of the P-channel signal.
25

When, as stated in claim 2, the said unit further comprises a direction rendering unit (201) having an input for signals having N directional components,

the said direction rendering unit (201) establishing a P channel output signals on an
30   output of the rendering unit (201) corresponding to input signals having N directional components, a further advantageous embodiment of the invention has been obtained.

Accordingly, a modular rendering of a P-channel sound image as a separate rendering stage provides a uniform rendering of all the input sources.

A further aspect of the above embodiment of the invention is that the early pattern module and the P-channel rendering stage may be adjusted and tuned individually.

A typical number of channels, i.e. the value of P, may vary from a stereo application having two channels or e.g. five channels up to e.g. twenty channels. Of course, the upper limit may be higher if appropriate.

When, as stated in claim 3, the said P channel output signals are established in such a way that they correspond to a P-channel trans- or bin-aural representation of the said N-directional input signal, an advantageous embodiment of the invention has been obtained.

When, as stated in claim 4, the said P channel output signals are established in such a way that they correspond to an experience-based P-channel representation of the said N-directional input signal, a further advantageous embodiment of the invention has been obtained.

Other rendering methods within the scope of the invention may be P- channel vector-based amplitude panning of the N-directional input or P-channel based intensity panning of the N-directional input or combinations of the above mentioned methods.

When, as stated in claim 5, the said signal processing unit further comprises a circuit (202, 203) having S inputs and P outputs, the said S inputs being individual input channels for S input sources,
the said P channel outputs comprising a P-channel late reverberation signal,
the said signal processing unit further comprising a summing unit (204)
the said summing unit (204) adding the said late reverberation signal to the
the said established P-channel output signals of the said direction rendering unit (201), a further advantageous embodiment of the invention has been obtained.

5

Hence, the reverberation signals may be added subsequently to the rendering of the established sum signal without disturbing the sound image to the listener due to the fact that the reverberation sound tail is more or less diffuse and consequently not

5   very directional.

The modular adding of the sound tail to the established P-channel signal provides a further possibility of separate tuning of the modules in a very advantageous way as the establishing of a sound tail signal may be tuned more or less independently of the

10   tuning of the S source early pattern generation stage and the rendering stage.

It should be noted, that the above reverberation stage should be tuned to fit to the specific chosen number of channels P.

15   When, as stated in claim 6, the rendering unit comprises an input for N directional signals,
the said direction rendering unit (201) establishing a P channel output signal on an output of the rendering unit (201) corresponding to input signals having N directional components, a further advantageous embodiment of the invention has been obtained.

20

Accordingly, a rendering may be established independently of the location and number of all the input sources, as the rendering stage input is only one signal having N-directions.

25   A possible embodiment of the invention implies a five channel rendering of 10-directional signal where the directions of the input signal format are 0, +/-15, +/-30, +/-70, +/-110 and 180 degrees and the intended location of the five channels are 0, +/-30 and +/-110 degrees.

30   Obviously, several other directions and locations are applicable. A preferred embodiment comprises more than 20 directions.

6

Again, it should be noted that rendering of the sound signal may be established independently of how the input signal is generated.

When, as stated in claim 7, the said P channel output signals are established in such a

5 way that they correspond to a P-channel trans-aural representation of the said N-directional input signal, a further advantageous embodiment of the invention has been obtained.

When, as stated in claim 8, the said P channel output signals are established in such a

10 way that they correspond to an experience-based P-channel representation of the said N-directional input signal, a further advantageous embodiment of the invention has been obtained.

When, as stated in claim 9, the early pattern generation mixer (29) comprises

15 M inputs, each input receiving early pattern signals comprising N directional components,
the said mixer (29) further comprising at least one output, the said at least one output transmitting an N-directional early patterns signal,
the said N-directional early patterns signal being established by adding the said M

20 inputs, a further advantageous embodiment of the invention has been obtained as a mix of the very complex directional signal may be established by simple summing.

When, as stated in claim 10, the signal processing unit comprises
at least one input (S),

25 at least one of the said inputs (S) being connected to at least one space processor,
at least one space processor defining at least a generation of an early pattern
each of said space processors establishing an output (d1, d2, d3, d4,..,dN) having N directional components,
each of the said directional components (N) of the said outputs being added to form

30 at least one signal having N directional components, a further advantageous embodiment of the invention has been obtained.

When, as stated in claim 11, the method of representing an audio-signal, wherein said signal is decomposed to a signal comprising N directional components, an advantageous signal representation has been obtained as a directional representation facilitates the possibility of a true and relatively simple processing of even very complicated audio signal scenarios.

Moreover, the approach of representing an audio signal as N directional components provides the possibility of treating both 0th order signal, i.e. the direct sound, as well as more complicated reflection signals (i.e. 1st and higher order reflections) in the same way and consequently under the same simulating conditions. Thus, the signal representation, according to the invention, provides a possibility of creating true correspondence between the direct sound and the resulting reflections in the sense that a signal may conveniently be represented as having both the direct sound and the reflections.

Moreover, the directional quantified representation provides a very distinct and accurate way of establishing a desired signal in a certain direction. It should be noted that traditional directional emulation is more or less based on individual panning of the different sound sources. According to the representation invention, the only uncertainty with respect to the directionality of the established sound signals refers to the method by which the directional representation is mapped (i.e. rendered) to a given number of channels. Nevertheless, it should be emphasised that the mutual directional spacing between sound signals is maintained as the rendering method is the same for all signals as has already been mentioned above. Consequently, the relative directional positioning is established by the signal format and not by sound engineers bound by traditional panning.

Thus, if distinct representations are desired, a high number of quantised directional components may be chosen.

Preferably, the N-directional components should of course represent a given signal at a specific geometrical position.

When, as stated in claim 12, the said signal is decomposed to a signal comprises N directional components by means of dedicated signal-processing means, an advantageous embodiment of the invention has been obtained as the signals may be established in real-time.

When, as stated in claim 13, the method of processing audio signals comprises M sub-signals, each sub-signal being represented as a signal having N directional components (d1, d2, d3, d4,..), the said sub-signals being added to form a sum-signal having N directional components ($\Sigma d1$, $\Sigma d2$, $\Sigma d3$, $\Sigma d4$,..,ΣdN), where $\Sigma di(i=1..N)$ is the sum of signal components in one of the N directions, the said sum-signal representing the resulting audio signal, a further advantageous embodiment of the invention has been obtained as even very complicated audio-signals may be added by means of conventional summing means to form a complex and true signal which may establish several sound source positions in one signal.

When, as stated in claim 14, the signal processing unit comprises
at least one input (S),
at least one of the said inputs (S) being connected to at least one reverberation unit
at least one reverberation unit defining a predefined reverberation generation
each of the said reverberation units establishing an output (d1, d2, d3, d4,...) having N directional components,
each of said directional components (N) of said outputs being added to form at least one signal having N directional components, a further advantageous embodiment of the invention has been obtained as the signal-representation and signal-processing algorithm may basically be processed on both initial sound signals and the sound tail signal as well according to the invention.

The figure

The invention will be described below with reference to the drawings of which

fig.1   shows the basic understanding of a reverberated sound

fig.2	shows the basic principles of a sound processing device according to the invention
fig.3a-3c	shows different sub-portions of the system according to the invention and
fig. 4a-4b	illustrates early pattern generators according to the invention

Detailed description

According to most embodiments of the invention, it is the general approach that artificial generation of room simulated sound should comprise an early reflection pattern and a late sound sequence, i.e. a tail sound signal.

It should be noted that the invention is basically directed at the early reflection patterns, and consequently sound processing based on early reflections patterns within the scope of the invention.

Fig. 1 illustrates the basic principles of a conventional signal processing unit.

The circuit comprises an input 1 communicating with an initial pattern generator 2 and a subsequent reverberation generator 3. In addition, the initial pattern generator 2 and the subsequent reverberation generator 3 are connected to two mixers 4, 5 having output channels 6 and 7, respectively.

The initial pattern generator 2 generates an initial sound sequence with relatively few signal reflections characterising the first part of the desired emulated sound. It is a basic assumption that the initial pattern is very important as a listener establishes a subjective understanding of the simulated room on the basis of even a short initial pattern.

An explanation of this performance is that this signal reception corresponds to the actual sound propagation and reflection in a real life room.

Hence, reflections in a certain room will initially comprise relatively few reflections, as the first sound reflection, also called first order reflections, have to propagate from a sound source at a given position in the room to the listener's position via the nearest reflecting walls or surfaces. Compared with the overall heavy complexity of the technique, this sound field will be relatively simple and may therefore be emulated in dependency of the room and the position of the source and the listener.

Subsequently, and of course with some degree of overlapping, the next reflections will appear at the listeners position. These reflections, also called second order reflections, will be the sound waves transmitted to the position of the receiver via two reflecting surfaces.

Gradually, this sound propagation will increase in dependency of the room type, and finally the last reflected sound will be of a more diffuse nature as it comprises several reflections of several different orders at different times.

Apparently, the sound propagation will gradually result in a diffuse sound field and the sound field will more or less become a "sound soup". This diffuse sound field will be referred to as the tail sound.

If the walls have high absorption coefficients, the propagation will decrease quite fast after a short time period of time while the sound propagation will continue over a relatively long period of time if the absorption coefficients are low.

Fig. 2 illustrates the basic principles of a preferred embodiment of the invention.

For reasons of explaining, the shown embodiment of the invention has been divided into three modules 20A, 20B and 20C.

The first module 20A of the room simulator, according the embodiment shown, comprises M source inputs 21, 22, 23.

The source inputs 21, 22 and 23 are each connected to an early pattern generator 26, 27 and 28.

Each early pattern generator 26, 27 and 28 outputs M directional signals to a
5   summing unit 29. The summing unit adds the signal components of each of the N predetermined directions from each of the early pattern generators 26, 27 and 27.

The summing unit output N directional signals to the module 20B comprising direction rendering unit 201.
10

The basic establishing of the N directional signals has been illustrated in fig. 3a.

Now returning to fig. 2, the direction rendering unit converts the N directional signal to a P channel signal representation.
15

The basic establishing of the P channels of module 20B has been illustrated in fig. 3b.

Moreover, the system comprises a third module 20C. The module 20C comprises a
20   reverb feed matrix 202 fed by the M source inputs 21, 22, 23. The reverb feed matrix 202 outputs P channel signals to a reverberator 203 which, in turn, outputs a P channel signal to a summing unit 204.

Thus, the summing unit 204 adds the P channel output of the reverberator 203 to the
25   output of the direction rendering unit 201 and feeds the P channel signal to an output.

The basic establishing of the P channels of module 20C has been illustrated in fig. 3c.

30   Before explaining the overall functioning of the algorithm, the basic functioning of the early pattern generators 26, 27, 28 and the summing unit 29 will be explained with reference to fig. 3a

According to fig. 3a, the module 20A comprises a number of inputs S1, S2, S3 and S4.

5   It should be noted that a number of four inputs have been chosen for the purpose of obtaining a relatively simple explanation of the basic principles of the invention. Many other input numbers may be applicable.

Each of the inputs are directed to an early pattern generator 26, 27 and 28. Each early
10   pattern generator generates a processed signal specifically established and chosen for the source input S1, S2, S3 and S4. The processed signals, according to the shown embodiment, are established as a signal composed of seven signal components d1, d2, d3, d4, d5, d6 and d7. The seven signal components represent a directional signal representation of the established sound and the established signal contains both the
15   direct sound and the initial reverberation sound.

A possible embodiment of the invention implies a five channel rendering of 10-directional signal where the directions of the input signal format are 0, +/-15, +/-30, +/-70, +/-110 and 180 degrees, and the intended location of the five corresponding
20   loudspeakers are 0, +/-30 and +/-110 degrees according to ITU 775.

Obviously, several other directions and locations may be applicable. A preferred embodiment comprises more than 20 directions.

25   Accordingly, each of the inputs S1, S2, S3 and S4 may refer to mutually different locations of the input source to which the early pattern is generated.

Successively, the signals from each source are summed in summing unit 29. The summing is carried out as a simple adding of each signal component, i.e.
30     $d1:=d1(S1)+ d1(S2)+ d1(S3)+ d1(S4)$, $d2:=d2(S1)+ d2(S2)+ d2(S3)+ d2(S4)$, $d3:=d3(S1)+ d3(S2)+ d3(S3)+ d3(S4)$, $d4:=d4(S1)+ d4(S2)+ d4(S3)+ d4(S4)$,

$d5:=d5(S1)+ d5(S2)+ d5(S3)+ d5(S4)$, $d6:=d6(S1)+ d6(S2)+ d6(S3)+ d6(S4)$ and $d7:=d7(S1)+ d7(S2)+ d7(S3)+ d7(S4)$.

It should be noted that, even though undesired, according to the preferred embodiment of the invention, the signals d1,..,d7 may comprise tail sound components or even whole tail-sound. It should nevertheless be emphasised that according to the preferred embodiment of the invention such tail sound may advantageously be generated according to a relatively simple panning algorithm and subsequently added to the established summed initial sound signal as the established summed initial sound comprises the dominating room determining effects.

Moreover, it should be emphasised that a separate tuning of the resulting tail-sound signal is much easier when made separately from the individual tuning of the different source generators.

Turning now to module 20B, fig. 3b illustrates the basic functioning of the direction rendering unit 201.

According to the shown embodiment of the invention, the seven directional signal outputs from module 20A are mapped into a chosen multi-channel representation. According to the illustrated embodiment, the seven directional signals are mapped to a P=5 channel output.

According to a preferred embodiment of the invention, the type of multi-channel representation is a selectable parameter, both with respect to number of applied channels and to the type of speaker setup and the individual speaker characteristics.

The conversion into a given desired P channel representation may be effected in several different ways such as implying HRTF based (head related transfer function), a technique mentioned as Ambisonics, VBAP (vector based amplitude panning) or a pure experience based subjective mapping.

Turning now to fig. 3c module 20C is illustrated as having an input from each of the source inputs S1, S2, S3 and S4. The signals are fed to a reverb feed matrix 202 having five outputs, corresponding to the chosen channel number of the direction rendering unit 201. The five channel outputs are fed to a reverberation unit 203

5   providing a five channel output of subsequent reverberation signals.

The reverb feed matrix 202 comprises relatively simple signal pre-processing means (not shown) setting the gain, delay and phase of each input's contribution to each reverb signal and may also comprise filtering pre-processing means.

10

Subsequently, the reverberation unit 203 establishes the desired diffuse tail sound signal by means of five tank circuits (not shown) and outputs the resulting sound signal to be added to the already established space processed initial sound signal. According to the illustrated preferred embodiment of the invention, the tail sound

15   generating means are added using almost no space processing due to the fact that a space processing of the tail sound signal according to the diffuse nature of the signal has little or no effect at all. Consequently, the complexity of the overall algorithm may be reduced when adding the tail sound separately and making the tuning much easier.

20

Moreover, it should be noted that the above mentioned separate generation of the tail-sound provides a more natural diffuse tail-sound due to the fact that the distinct comb-filter effect of the early pattern generator should preferably only be applied to the initial pattern in order to provide naturalness.

25

It should be noted that the above generation of subsequent reverberation signals, according to the present preferred embodiment, is generated independently of the initial sound generation. Nevertheless, it should be emphasised that the invention is in no way restricted to a narrow interpretation of the basic generation of a

30   reverberation sound. Thus, within the scope of the invention, both the initial sound and the sound tail of each sound may of course be located within an artificial room and subsequently summed in a summing unit.

Turning now to fig. 4a, an early pattern generator, such as 26 of fig. 2, is illustrated in detail. The early pattern generator is one of four according to the above described illustrative embodiment of fig. 2, and each generator comprises a dedicated source
5   input S1, S2, S3 and S4.

The shown early pattern generator 26 comprises a source input S1.

According to the shown embodiment, the source input is connected to a matrix of
10 signal processing means. The shown matrix basically comprises three rows of signal processing lines, which are processed by shared diffusers 41, 42.

Accordingly, the upper row is fed directly from the input S1, the second row is fed through the diffuser 41, and the third row is fed through both diffusers 41 and 42.
15

Each row of the signal processing circuit comprises colour filters 411, 412, 413; 421, 422, 423; 431, 432, 433. According to the shown embodiment, colour filters of the same columns are identical, i.e. colour filter 411=421=431.

20 It should nevertheless be emphasised that the colour filters may of course differ within the scope of the invention.

Moreover each row comprises delay lines 4111, 4121 and 4131 which are serially connected to the colour filters 411, 412, 413. Finally, each column may be tapped via
25 level and phase controllers such as 4000, 4001 and 4002. It should be noted that each level-phase controller 4000, 4001 and 4002 are tap specific.

Hence, the initial pattern generator 26 comprises a matrix which may comprise several sets of predefined presets by which a certain desired room may be emulated.
30

As already mentioned and according to the simplified embodiment of the invention, signals of the current predefined room emulation are tapped to the directional signal

representation of the present sound source S1. According to the illustrated programming, four signal lines are tapped to seven directional signal components. One signal, N13 of row 1, column 3, is fed to sound component 1, one signal, N21, is fed to signal component 3, and two signals, N11 and N22 are added to the sound

5   component 4.

It should be noted that each tapped signal has consequently been processed through one of three combinations of diffusers, one of three types of predefined colour filters EQ, a freely chosen length of delay line and a freely chosen level and phase output.

10

Obviously, several other combinations and number processing elements are applicable within the scope of the invention.

According to one of the preferred embodiment of the invention, a separate row with a

15   level-phase controller 4002 should be tapped and determine the direct sound. When integrating the direct sound into the early pattern generation, the location of both the direct sound as well as the corresponding EPG and reverberation sound signals may be mapped into the sound signal representation completely similar to the desired directionality irrespective of directional resolution and complexity.

20

Evidently, the directional signal representation components usually comprise signals fed to each component 1-7 and not only the illustrated three.

It should be noted, that the chosen topology of the early pattern generator within the

25   scope of the invention may be chosen from a set of more or less equivalent topologies. Moreover, the signal modifying components may be varied, if e.g. a certain degree of tail-sound is added before or after tapping.

As the illustrated early pattern generator comprises linear systems, it will be possible

30   to interchange the components, e.g. the colour filters EQ may be interchanged with the diffusers DIF.

Fig. 4b illustrates a further possible embodiment of the early pattern generator, comprising colour filters EQ placed in the feed line to each row and diffusers DIF placed in each column in each row.

5   Likewise, the number of columns and rows may vary depending of the system requirements. In a possible embodiment only one column of delay lines with corresponding colour filters or diffusers is utilised. Moreover, additional components, additional diffusers, additional different types of colour filters, etc. may be chosen.

10

Finally it should be mentioned that, according to a preferred embodiment of the invention, the number of directions, i.e. signal components, should be not less than twelve, and the established reflections of each early pattern generator should not be less than 25.

15

The basic presetting of each early pattern generator may initially be determined by known commercially available ray tracing or room mirroring tool, such as ODEON.

18

CLAIMS

1. Signal processing unit comprising

5   at least one input (S),

at least one of the said inputs (S) being connected to at least one early patterns generator (M),

10   at least one early pattern generator (M) defining a predefined early pattern generation

each of the said early pattern generator (M) establishing an output (d1, d2, d3, d4,...) having N directional components,

15   each of said directional components (N) of said outputs (d1, d2, d3, d4,...) being added to form at least one signal having N directional components.

2. Signal processing unit according to claim 1, wherein the said unit also comprises a direction rendering unit (201) with an input for signals having N directional
20   components,

the said direction rendering unit (201) establishing a P channel output signals on an output of the rendering unit (201) corresponding to input signals having N directional components.

25

3. Signal processing unit according to claim 2, wherein said P channel output signals are established in such a way that they correspond to a P-channel trans- or bin aural representation of the said N-directional input signal.

30   4. Signal processing unit according to claim 2, wherein the said P channel output signals are establishes in such a way that it corresponds to an experience-based P-channel representation of the said N-directional input signal

5. Signal processing unit according to claims 1 to 4, wherein the said signal processing unit also comprises a circuit (202, 203) having S inputs and P outputs, the said S inputs being individual input channels for S input sources,

the said P channel outputs comprising a P-channel late reverberation signal,

the said signal processing unit further comprising a summing unit (204)

the said summing unit (204) adding the said late reverberation signal to the said established P-channel output signals of the said direction rendering unit (201)

6. Rendering unit comprising an input for N directional signals,

the said direction rendering unit (201) establishing a P channel output signal on an output of the rendering unit (201) corresponding to input signals having N directional components.

7. Rendering unit according to claim 6, wherein the said P channel output signals are established in such a way that they correspond to a P-channel trans-aural representation of the said N-directional input signal.

8. Rendering unit according to claim 6, wherein the said P channel output signals are established in such a way that it corresponds to an experience-based P-channel representation of the said N-directional input signal

9. Early pattern generation mixer (29) comprising

M inputs, each input receiving early pattern signals comprising N directional components,

the said mixer (29) further comprising at least one output, the said at least one output transmitting an N-directional early patterns signal,

<

5   The said N-directional early pattern signal being established by adding the said M inputs.

10. Signal processing unit comprising

10   at least one input (S),

at least one of the said inputs (S) being connected to at least one space processor,

at least one space processor defining at least a generation of an early pattern

15
each of the said space processors establishing an output (d1, d2, d3, d4,..dN) having N directional components,

each of the said directional components (N) of the said outputs (d1, d2, d3, d4,…)
20   being added to form at least one signal having N directional components.

11. Method of representing an audio-signal, wherein the said signal is decomposed to a signal comprising N directional components.

25   12. Method according to claim 11, wherein the said signal is decomposed to a signal comprising N directional components by means of dedicated signal-processing means.

13. Method of processing audio signals comprising M sub-signals, each sub-signal
30   being represented as a signal having N directional components (d1, d2, d3, d4,..,dN), the said sub-signals being added to form a sum-signal having N directional components (Σd1, Σd2, Σd3, Σd4,..,ΣdN) where Σdi(i=1..N) is the sum of signal

components in one of the N directions, the said sum-signal representing the resulting audio signal.

14. Signal processing unit comprising

5

at least one input (S),

at least one of the said inputs (S) being connected to at least one reverberation unit

10 at least one reverberation unit defining a predefined reverberation generation

each of the said reverberation units establishing an output (d1, d2, d3, d4,..,dN) having N directional components,

15 each of the said directional components (N) of the said outputs (d1, d2, d3, d4,...) being added to form at least one signal having N directional components.

20

Abstract:

The invention relates to a signal processing unit comprising

5   at least one input (S),

at least one of the said inputs (S) being connected to at least one early pattern generator (M),

10   at least one early pattern generator (M) defining a predefined early pattern generation

each of the said early pattern generators (M) establishing an output (d1, d2, d3, d4,...,dN) having N directional components,

15   each of the said directional components (N) of the said outputs (d1, d2, d3, d4,...) being added to form at least one signal having N directional components.

When representing each source output in a direction containing representation both directionality of the individual sound sources as well as the resulting directionality of
20   the excited sound propagation may be contained and processed in a simple processing algorithm.

1/4
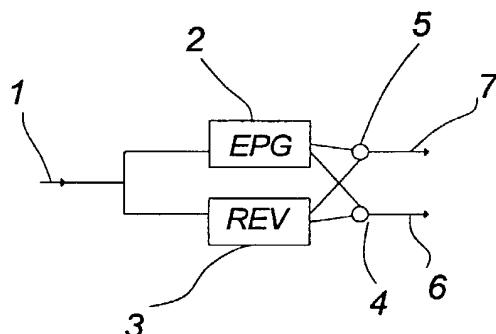
Fig.1
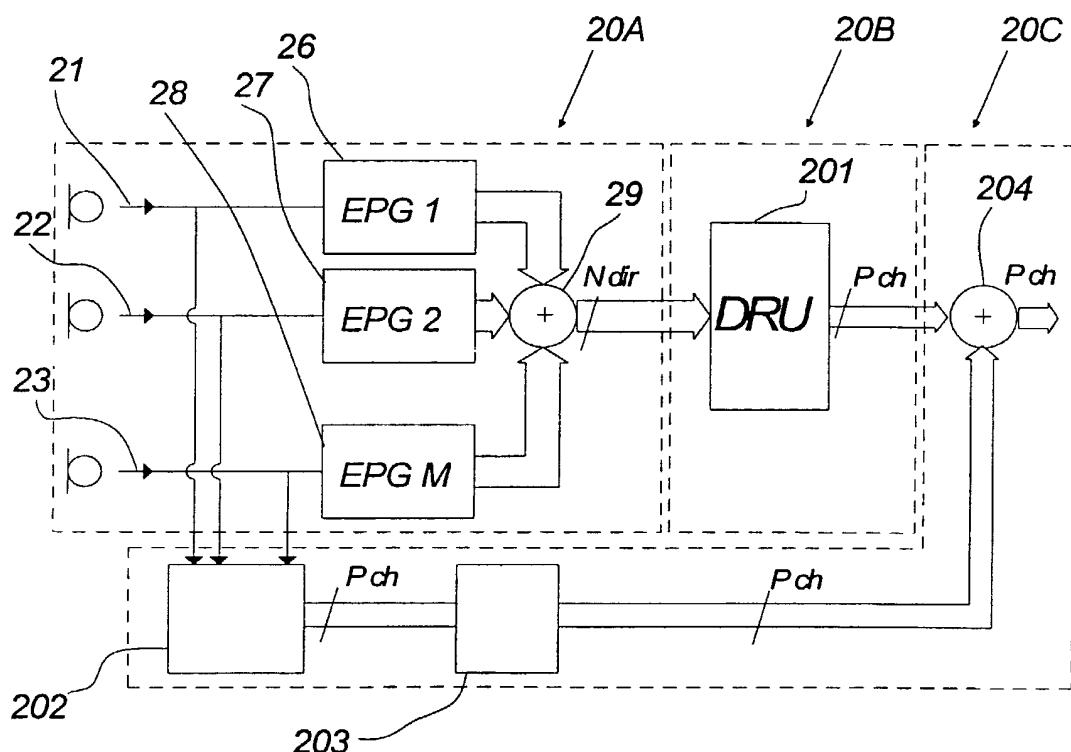
Fig.2

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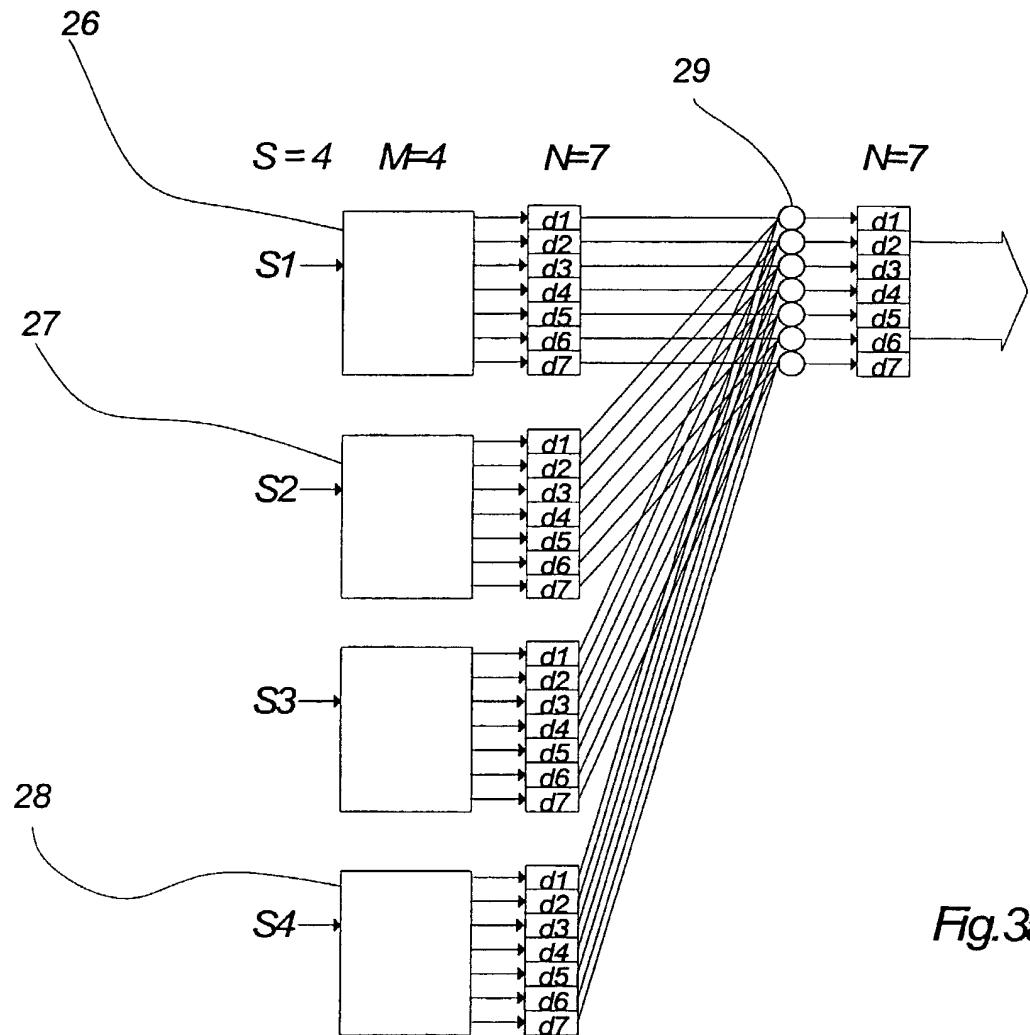
Fig.3a

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Fig.3b

Fig.3c

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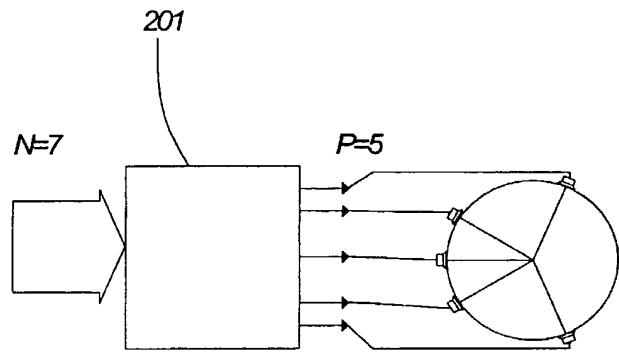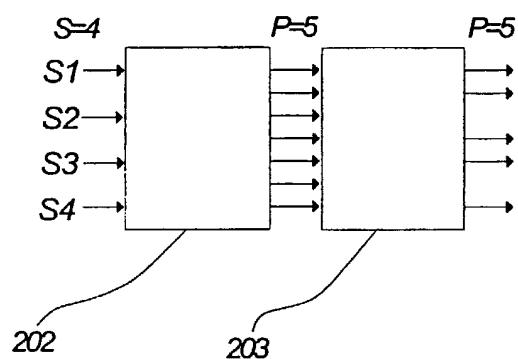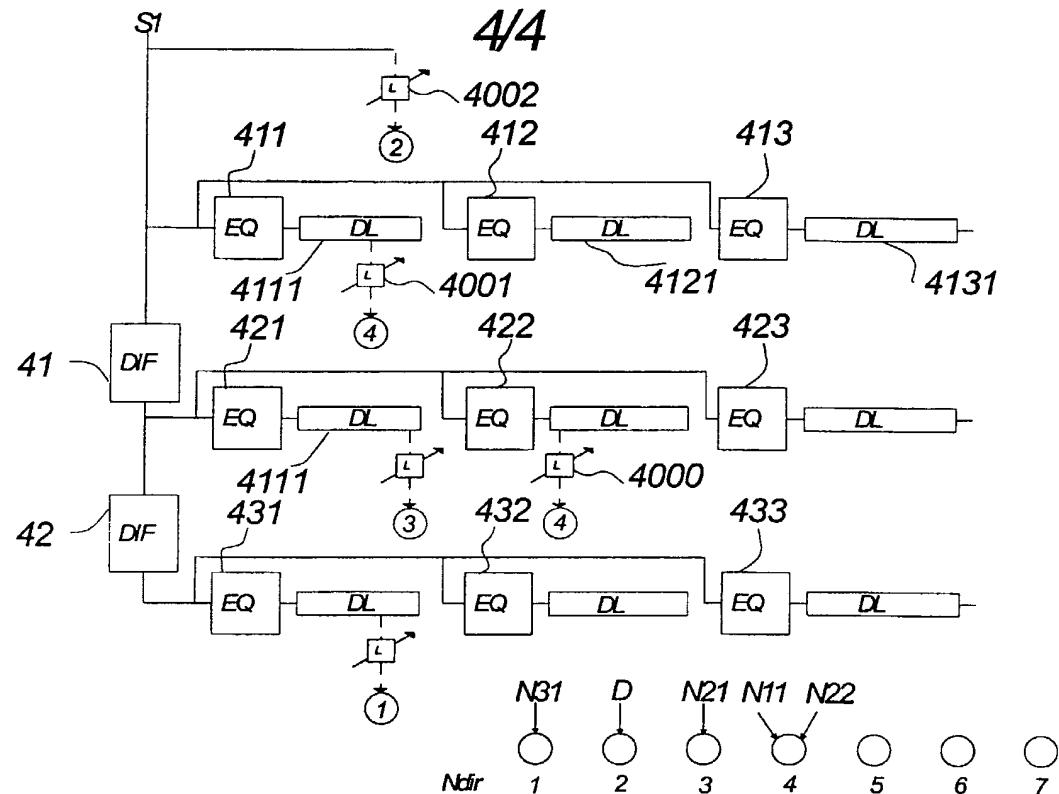

Fig.4a
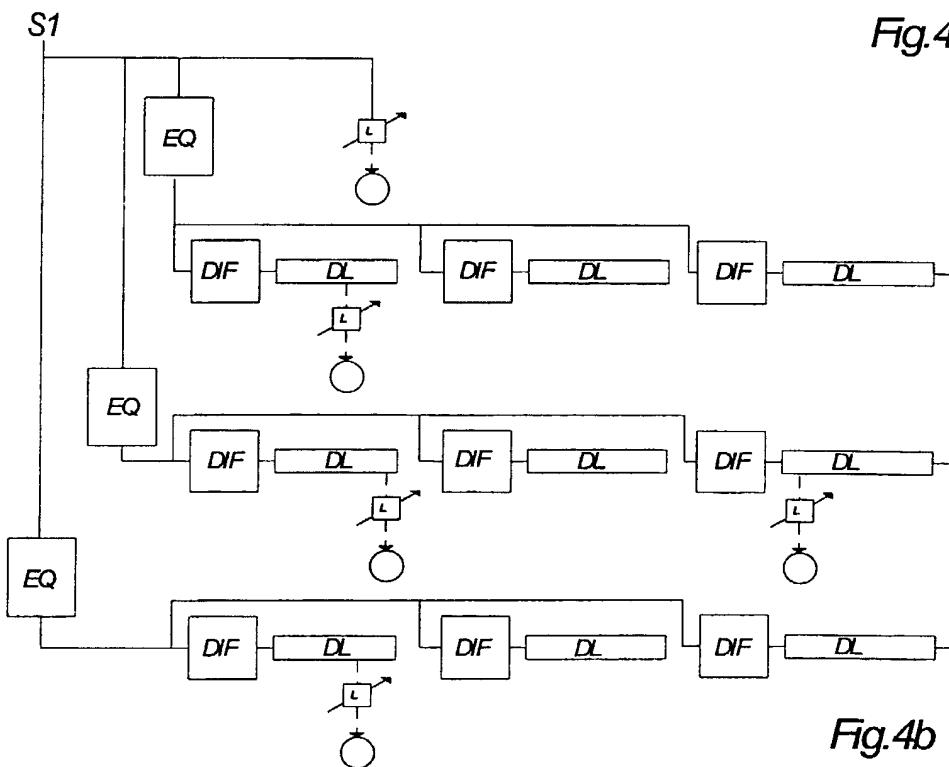

Fig.4b

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my/our name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled SIGNAL PROCESSING UNIT the specification of which

(check one)

       _____ is attached hereto.

       _X_ was filed on August 9, 2000 as

          Application Serial No. 10/049,415

          and was amended on February 8, 2002

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, 1.56(a).

I hereby claim foreign priority benefits under title 35, United States Code 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s).

			Priority Claimed
99202585.8	EPO/NL	9 August 1999	(Yes) No
(Number)	(Country)	(Day/Month/Year Filed)	
			Yes No
(Number)	(Country)	(Day/Month/Year Filed)	
			Yes No
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/DK00/00442	9 August 2000	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER   FILING DATE

_____   _____

_____   _____

_____   _____

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

23413

PATENT TRADEMARK OFFICE

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(860) 286-2929

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

Full name of sole
or first inventor: Kim Rishøj Pedersen
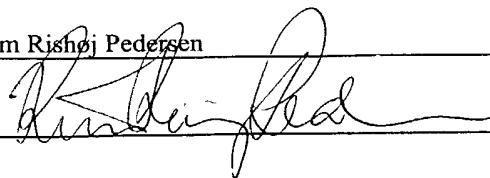
Inventor's signature: _____   14/5/2002
                                                      Date

Residence: Egå, Denmark   DK X

Citizenship: Denmark

Post Office Address: Skæring Sandager 54, 8250 Egå , Denmark

2-00

Full name of second
joint inventor, if any: Knud Bank Christensen
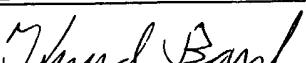
Inventor's signature: _____   14/5 -02
                                                      Date

Residence: Ryomgård, Denmark   DK X

Citizenship: Denmark

Post Office Address: Skovvej 2, 8550 Ryomgård, Denmark

3-00

Full name of third
joint inventor, if any: Morten Lave
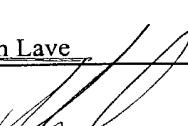
Inventor's signature: _____   14/5/2002
                                                      Date

Residence: Højbjerg, Denmark   DK X

-4-

Citizenship: Denmark _____

Post Office Address: Jelshøjvænget 30, 8270 Højbjerg, Denmark _____

Full name of fourth
joint inventor, if any: _____

Inventor's signature: _____   _____
                                                              Date

Residence: _____

Citizenship: _____

Post Office Address: _____